

STEREO

Instrument Data Processing Unit (DPU)

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STEREO

Instrument Data Processing Unit (DPU)

- Requirements
- Unknowns
- Past Systems (NEAR/ACE/Cassini)
- Current Efforts (Mini Modular DPU)
- STEREO Baseline
- STEREO Options

DPU System Requirements

- Provide custom interfaces to a variety of different instruments:
 - EDP
 - RBT
 - SWPA
 - MAG
- Provide processor services to the instruments as needed:
 - data formatting
 - data compression
 - command formatting
 - mechanism control
- Provide a simple interface to the STEREO spacecraft:
 - primary power
 - 1553 bus

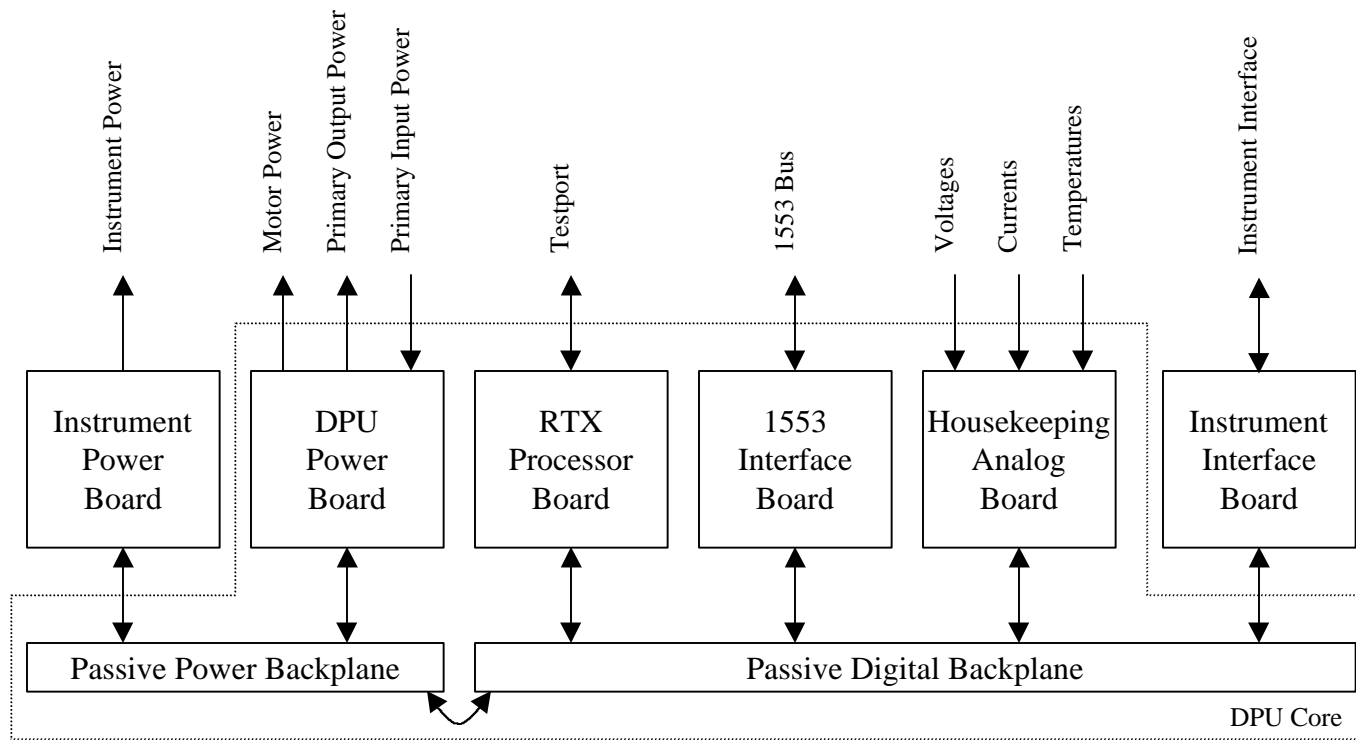
DPU System Unknowns

- Which instruments will require a DPU?
 - Answer not possible until AO responses are evaluated.
- Which processor services will be required by the instruments?
 - Answer not possible until AO responses are evaluated.
- What types of interfaces will be required by the instruments?
 - Serial or parallel?
 - Analog or digital?
 - High rate or low rate?
 - Differential or single-ended?
- Any “baseline” design presented at this point is purely hypothetical.

NEAR/ACE/Cassini Systems

- A modular instrument DPU design is in use on several spacecraft:
 - NEAR (MSI, XGRS and NIS/MAG)
 - ACE (ULEIS)
 - Cassini (MIMI)
- All DPUs use the same processor board.
- All NEAR DPUs use the same 1553 board and housekeeping board.
- All NEAR and ACE DPUs use the same DC/DC converter board.
- Custom instrument interface boards were added for each DPU.
- Custom instrument DC/DC converter boards were added on NEAR.

NEAR/ACE/Cassini Systems



NEAR/ACE/Cassini Systems

- Prior DPU configurations
 - NEAR Multi-Spectral Imager DPU 8 boards 4.0 Kg
 - NEAR X-Ray / Gamma-Ray Spectrometer DPU 6 boards 3.2 Kg
 - NEAR IR Spectrometer / Magnetometer DPU 6 boards 3.1 Kg
 - ACE Ultra Low Energy Isotope Spectrometer DPU 3 boards 1.9 Kg
- Prior DPU board weights and powers
 - RTX Processor Board 208 grams 1.0 W
 - 1553 Interface Board 214 grams 0.5 W
 - Housekeeping Analog Board 203 grams 0.5 W
 - DPU Power / Motor Board 375 grams depends
- Board size was 5.0 by 6.0 inches
- Footprint was approximately 6.5 by 7.0 inches without mounting feet

Mini Modular DPU

- Maintain the modular electronics partitioning used in past systems
 - Processor
 - 1553
 - Housekeeping
 - Power
 - Custom boards as needed
- Eliminate motherboard / daughterboard configuration
 - “Stackable” inter-board connector (save weight and design time)
 - “Sea of Actels” expansion bus system (maximum flexibility)
- Develop modular electronics housing
 - “chassis slice” packaging (save design time)
 - MDM connectors for signals (allows thin chassis slice)
 - D connectors for power

Mini Modular DPU

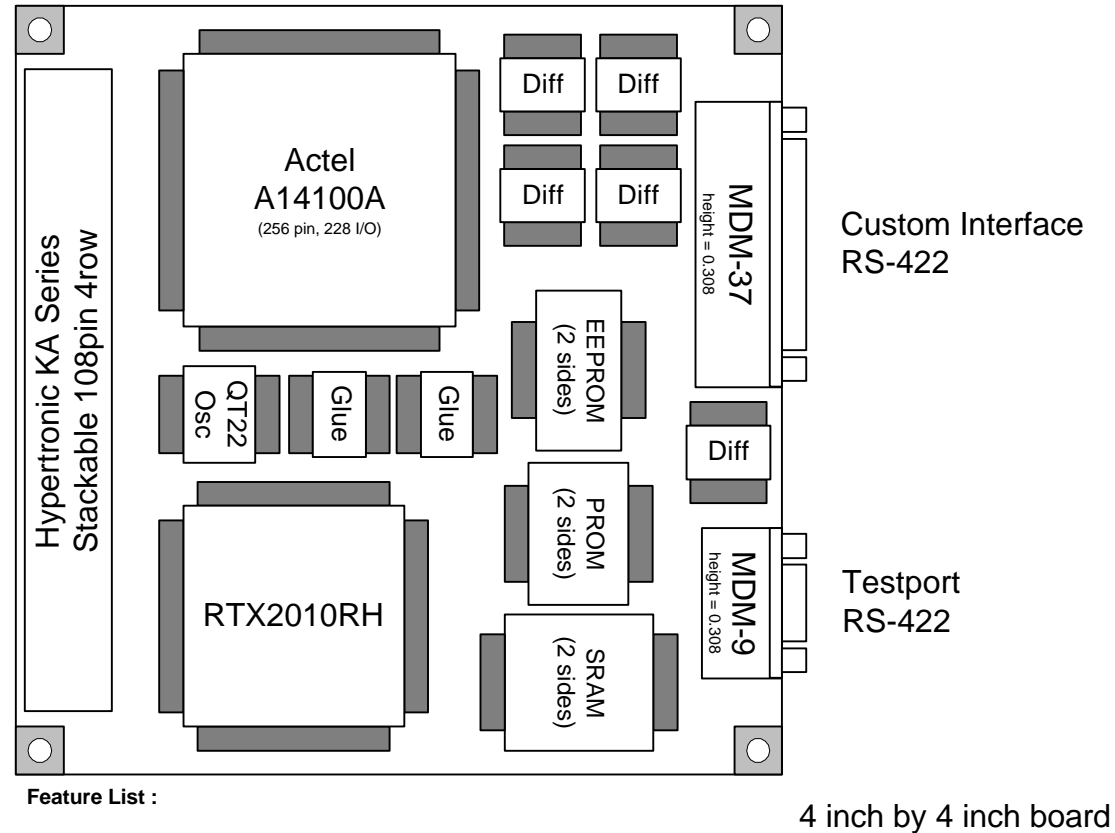
- Chassis slice packaging developed for C&DH In Your Palm effort
 - Binh Le and Rich Conde IRAD effort.
 - 4 by 4 inch section, 0.5 inch thick.
 - Intended for chip on board demonstration.
 - Can be lightened for use with conventional IC packaging.
- Horizontal stacking allows each board to contact deck
 - Avoids thermal pile-up experienced in NEAR DPUs with vertical stacking.
 - Mounting feet only on end of stack to allow for external connectors.
- Right angle connector saver for stacking connector
 - Allows for testing in a backplane system before stacking.
- One flight-qualified stacking connector type identified
 - Many commercial connector systems available.

Mini Modular DPU

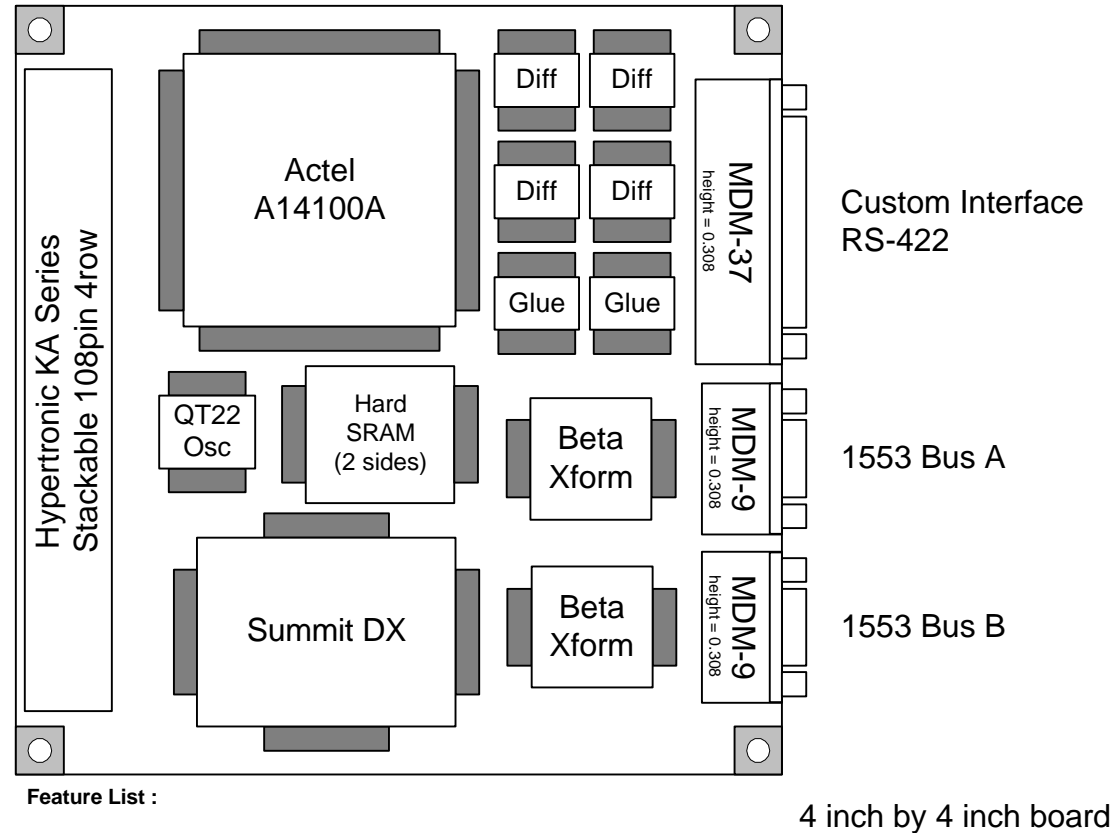
- Processor board baseline
 - RTX2010RH processor (16 bit, fixed point, 6+ MIPS)
 - 256 Kbytes SRAM
 - 256 Kbytes EEPROM
 - 16 Kbytes PROM
- Estimated DPU board weights and powers
 - RTX Processor Board 125 grams 1.0 W
 - 1553 Interface Board *** 125 grams 0.5 W
 - Housekeeping Analog Board *** 125 grams 0.5 W
 - DPU Power / Motor Board 200 grams depends

» *** these boards will approach 1.0 W with the external interface in use.
- Typical instrument interface boards will be between 0.5 W and 1 W depending upon configuration.

RTX Processor Board Concept

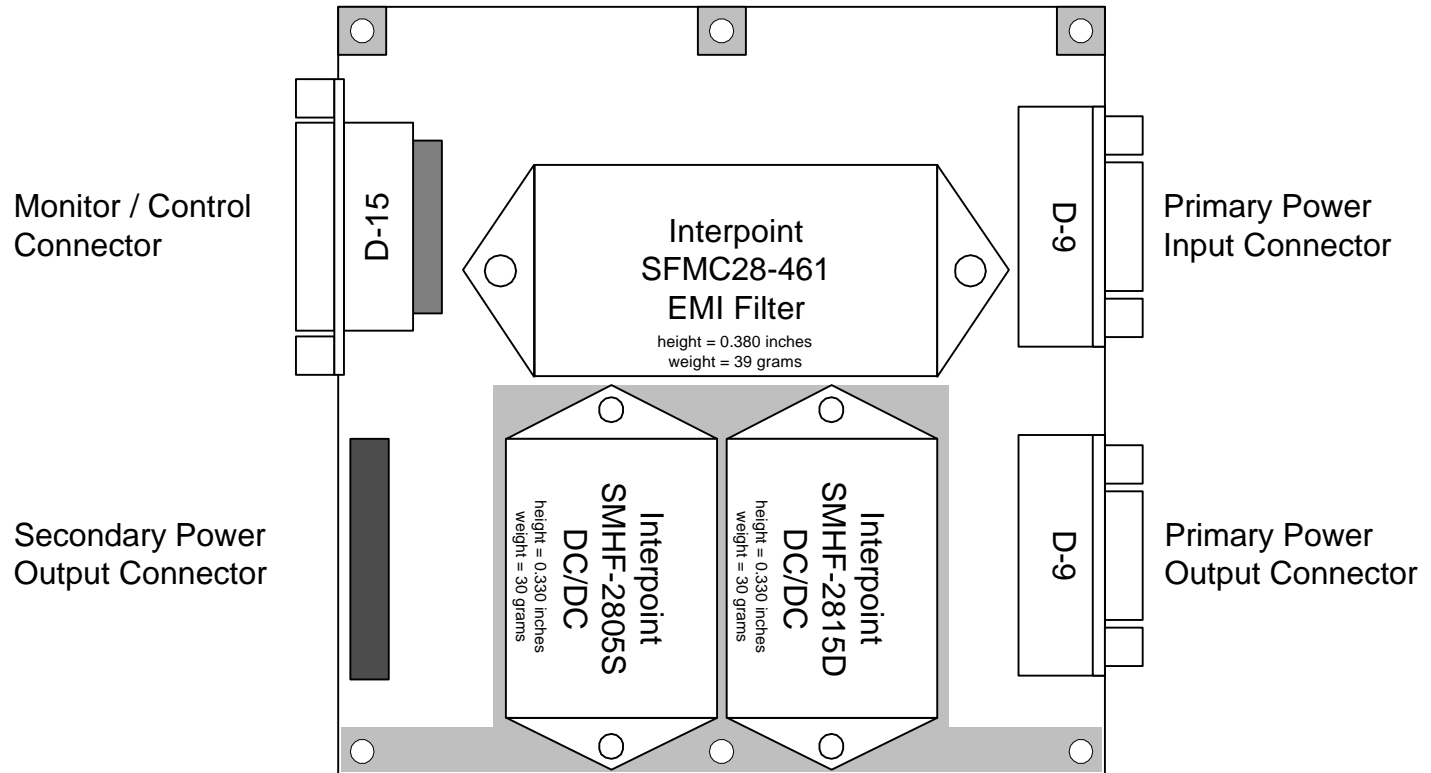


1553 Interface Board Concept



1. Stackable connector for expansion.
2. MDM connector for 1553 Bus A.
3. MDM connector for 1553 Bus B.
4. MDM connector for custom interface.
5. 32K*16 SRAM.
6. Actel acts as the expansion bus interface. Bus termination resistors are not shown.
7. More than half of the Actel would be available to configure an external interface.

DPU Power Board Concept

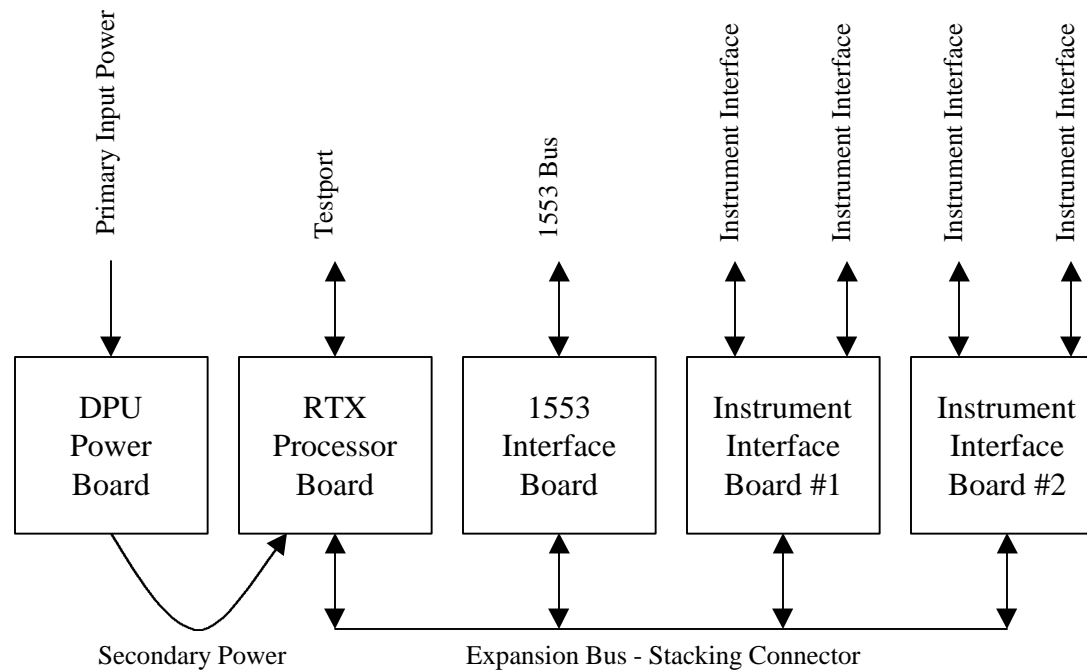


Feature List : 0.21 cubic inch of AL heatsink = 9.3 grams

4 inch by 4 inch board

1. D connector for primary power input.
2. D connector for primary power output (switched).
3. D connector for monitoring.
4. Header connector for secondary power output.
5. In-rush current limiter.
6. Undervoltage lockout.

STEREO Baseline



Assumptions:

1. Instruments do not require secondary power from the DPU. (would require additional power boards)
2. Instruments do not require housekeeping analog telemetry monitoring. (would require additional housekeeping board)
3. Instruments do not require large data storage capacity in the DPU. (would require additional memory expansion board)
4. Spacecraft provides power switching to the instruments.
5. Instrument data processing is within the capability of a shared RTX2010 processor.

STEREO Baseline

- Baseline : 1 DPU handling 4 instruments

Unit	Board Weight	Chassis Weight	Power	Thickness
RTX Processor	125	25	1.00	0.50
1553 Interface	125	25	0.50	0.50
Instrument Interface#1	125	25	1.00	0.50
Instrument Interface#2	125	25	1.00	0.50
DPU Power	175	50	1.50	0.80
End Plate	0	65	0.00	0.06
End Plate	0	65	0.00	0.06
	675	280	5.00	2.92

Total 955 grams 5.00 watts

- Estimated DPU dimensions
 - 4.00 by 4.00 by 2.92 inches
 - excludes mounting feet

Assumptions:

1. Converter is 70% efficient.
2. Large mounting feet on the end plates and none on the chassis slices.
3. Basic material is 0.060 thick aluminum.

STEREO Options

- Option#1 : 2 DPUs handling 2 instruments each
 - Arguably more reliable configuration than a single DPU.
 - Arguably a simpler software development environment than a single DPU.
 - Higher performance than a single DPU at a higher cost.
 - Assume an additional instrument interface board.

RTX Processor	125	25	1.00	0.50
1553 Interface	125	25	0.50	0.50
Instrument Interface	125	25	1.00	0.50
DPU Power	175	50	0.64	0.80
End Plate	0	50	0.00	0.06
End Plate	0	50	0.00	0.06
	550	225	3.14	2.42

Total	775 grams	3.14 watts
Total for 2 units	1550 grams	6.29 watts

- Estimated DPU dimensions
 - 4.00 by 4.00 by 2.42 inches
 - excludes mounting feet

STEREO Options

- Option#2 : 4 DPUs handling 1 instrument each
 - Arguably the most reliable configuration.
 - Arguably the simplest software development environment.
 - Higher performance than a single DPU at a higher cost.
 - Assume the instrument can be interfaced via the RTX or 1553 boards.

Unit	Board Weight	Chassis Weight	Power	Thickness
RTX Processor	125	25	1.00	0.50
1553 Interface	125	25	0.75	0.50
DPU Power	175	50	0.75	0.80
End Plate	0	50	0.00	0.06
End Plate	0	50	0.00	0.06
	425	200	2.50	1.92

Total	625 grams	2.50 watts
Total for 4 units	2500 grams	10.00 watts

- Estimated DPU dimensions
 - 4.00 by 4.00 by 1.92 inches
 - excludes mounting feet

DPU Cost Issues

- Several factors would help to reduce the costs for this “new” system.
 - This is not a new system. It is an evolution of prior systems.
 - RTX Processor Board design is very close to existing designs.
 - 1553 Interface Board is a variation on the NEAR 1553 board.
 - DPU Power Board is very close to the existing design.
 - Existing core software can be re-used or re-hashed.
 - Forth operating system
 - UTMC Summit 1553 communications
 - Macro commands and command storage
 - Event based instrument autonomy rules
 - Loss-less data compression (Rice algorithm)